REMARKS

The Office Action mailed March 2, 3009, and made final, has been carefully reviewed and the foregoing amendment has been made in consequence thereof.

Claims 1, 2, 4-20, 25, 26, and 28-31 are now pending in this application. Claims 1, 2, 4-20, 25, 26, and 28-31 stand rejected. Claims 3, 21-24, and 27 have previously been canceled.

The rejection of Claims 1, 2, 4-20, 25, 26, and 29-31 under 35 U.S.C. § 101 for allegedly claiming an invention directed to non-statutory subject matter is respectfully traversed. More specifically, the Examiner asserts that Claims 1, 2, 4-20, 25, 26, and 29-31 are rejected because Claims 1, 2, 4-20, 25, 26, and 29-31 "are directed towards data processing and computer program per se which does not constitute a statutory process, machine, manufacture, or composition of matter. Furthermore, the claims fail to tie the process to another statutory class or indentify a transformation."

Applicants respectfully submit that Claims 1, 2, 4-20, 25, 26, 30, and 31, as amended, recite a method tied to a magnetic resonance imaging (MRI) machine that produces an image of an object, which is statutory subject matter. More specifically, the method is meaningfully limited to an MRI machine that produces an image. Applicants respectfully submit that Claim 29 recites a controller, which is a statutory machine and, as such, satisfies the requirements of Section 101. However, in order to expedite prosecution, Claim 29 has been amended to recite a controller configured to generate datasets representative of an object and output an image of the object.

The image produced in Claims 1, 2, 4-20, 25, 26, and 29-31 is representative of a physical object, namely an object positioned within an MRI machine. The datasets representing the physical object are transformed to produce an image of the object. In *In Re Bernard L. Bilski and Rand A. Warsaw*, the Federal Circuit held that a method that transforms data representing physical and tangible objects into a particular visual depiction of a physical object on a display is sufficient to render the claimed process patent-eligible. 545 F.3d 943, 962-63 (Fed. Cir. 2008). "[T]he electronic transformation of the data itself into a visual depiction in *Abele* was sufficient; the claim was not required to involve any transformation of the underlying physical object that the data represented." *Id.* at 963. As such, Applicants

respectfully submit that Claims 1, 2, 4-20, 25, 26, and 29-31 also satisfy the requirements of Section 101 because the method recited in Claims 1, 2, 4-20, 25, 26, and 29-31 transform the underlying subject matter.

For at least the reasons set forth above, Applicants respectfully request that the Section 101 rejection of Claims 1, 2, 4-20, 25, 26, and 29-31 be withdrawn.

Initially, with respect to the obviousness rejections set forth in the Office Action, Applicants respectfully submit that the Section 103 objections of the presently pending claims are improper. More specifically, Applicants respectfully traverse the Examiner's assertion at pages 2, 6, 8, 9, 11, and 13 of the Office Action that:

> paragraph 47 of the current application's own specification states, "It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and spiral imaging to generate MR signals representative of patient 135." Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention.

In contrast to such an assertion, Applicants respectfully submit that Applicants are free to define their invention more narrowly than what is disclosed in the specification and can limit the invention to a particular embodiment in the claims. As such, it is improper for the Examiner to import the description of sampling datasets by a variety of methods, such as simple phase encoding, EPI, and spiral imaging, from the specification into the claims. The MPEP recites that "it is important not to import into a claim limitations that are not part of the claim," (§ 2111.01(II)) and "[l]imitations appearing in the specification but not recited in the claim should not be read into the claim" (§ 2106(II)(C)). Accordingly, Applicants respectfully submit that Applicants have chosen to limit their invention to the elements recited in the claims and, as such, it is improper for the Examiner to read the broader description in the specification into the presently pending claims.

Further, Applicants respectfully traverse the Examiner's interpretation of Claims 1, 25, 26, 28, and 29 at pages 2, 6, 8, 9, 11, and 13 of the Office Action. More specifically, Section 2143.03 of the MPEP states that <u>all words</u> in a claim are to be considered in determining the patentability of a claim against prior art. (Emphasis added.) Applicants respectfully submit that the Examiner's interpretations do not consider all of the words of

Claims 1, 25, 26, 28, and 29. More specifically, at least the recitations directed to forming a nest loop using the claimed steps are not considered in the Section 103 rejection. Applicants respectfully request that all of the limitations of the presently pending claims be considered when rejecting the claims.

Applicants also traverse the Examiner's assertions that "The above cited references all teach either one of EPI or spiral imaging . . . Goto [teaches] methods of magnetic resonance imaging incorporating pulse sequences . . . While discussed with reference to gradient echo methods, other appropriate techniques include EPI." Applicants submit that it does not suffice that the prior art disclose or suggest alternative embodiments disclosed by Applicants. Rather, the references cited by the Examiner must include some description or suggestion of each of the claimed limitations. As discussed above, the claimed steps for forming a nested loop must be considered in determining the patentability of the presently pending claims, and the references cited by the Examiner must include some description or suggestion of such limitations for the claim to be unpatentable. Further, while the lexicography does not have to be interpreted literally, the Examiner must consider <u>all the words in the claims</u> and not omit recitations that are material to the patentability of a claim.

Moreover, Applicants respectfully note that the Office Action rejects several of the claims multiple times, for example, independent Claims 1, 2, and 4-7 are rejected four times, Claim 9 is rejected three times, and Claims 10, 19, and 26 are rejected twice. The third paragraph of MPEP § 904.03 recites:

> The examiner is not called upon to cite all references that may be available, but only the "best." (37 CFR 1.104(c).) Multiplying references, any one of which is as good as, but no better than, the others, adds to the burden and cost of prosecution and should therefore be avoided . . . .

Applicants respectfully request that, if the Examiner rejects the presently pending claims, only the best references, not all available references, be used in rejecting each claim.

It appears that each of the Section 103 rejections is also taken in view of the Examiner's Official Notice. Applicants proceed as though each Section 103 rejection is also taken in view of the Examiner's Official Notice.

The rejection of Claims 1, 2, 4-7, 9, 10, 12, 16-19, 26, and 28-31 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 4,727,325 to Matsui et al. (hereinafter

referred to as "Matsui") in view of U.S. Pat. No. 5,892,358 to King (hereinafter referred to as "King"), further in view of U.S Pat. No. 6,068,595 to Miyazaki et al. (hereinafter referred to as "Miyazaki") and further in view of U.S. Pat. Pub. 2001/0041819 to Goto (hereinafter referred to as "Goto") and the Examiner's Official Notice is respectfully traversed.

Matsui describes a NMR imaging method using a rotating field gradient. The method includes generating a field gradient in a predetermined direction to translate a position of signal in a phase space to appropriate locations, and generating the rotating field gradient to perform a measuring operation. The rotating field gradient produces a spiral or circular sampling of k-space which is then reconstructed through Fourier transformation or a combination of 2D interpolation and Fourier transformation to produce an image. The method includes varying the amplitude of a field gradient waveform and/or an angular frequency at which a field gradient vector is rotated. Signal sampling includes generating a 90° RF pulse and a field gradient G_Z to excite nuclear spins in a desired slice portion of an object to be inspected. When a time τ has elapsed after the peak of the 90° RF pulse, a 180° RF pulse is generated to form transverse magnetization when a time τ has elapsed after the 180° RF pulse, i.e., at a time $t=0$. At the time $t=0$, the field gradients G_x and G_y are generated, and a signal sampling operation is started.

King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory.

Miyazaki describes a method of magnetic resonance imaging wherein data reconstruction is accomplished either through a Fourier transform of raw data acquired by magnetic scan under a state wherein pulsed gradients are applied to the subject in phase-encoding, or through pixel addition or maximum intensity projection (MIP). To scan a patient (P), a controller (6) commands a sequencer (5) to start scanning. In response to the command, the sequencer (5) drives a transmitter (8T) and a gradient power supply (4), according to pulse-sequence information that is transmitted and stored, and executes scanning. For a first scan, fast spin echo imaging is selected, the phase-encoding direction is set to the Z-axis direction, and the readout direction is set to the X-axis direction (step S5-2). A phase-encoding direction for a second scan is set to a direction deviated from the phase-encoding direction for the first scan. For example, the phase-encoding direction is changed to the X-axis direction and the readout direction is changed to the Z-axis direction.

Goto describes a method of magnetic resonance imaging included a phase encode gradient that is varied during a pulse sequence to carry out the phase encoding.

The Examiner took Official Notice that "the Cartesian coordinate system is an arbitrary labeling of the axes." Applicants traverse the use of such Official Notice. MPEP section 2144.03 indicates that use of Official Notice should be rare, and that:

> [o]fficial notice unsupported by documentary evidence should only be taken by the examiner where the facts asserted to be well-known, or to be common knowledge in the art are capable of instant and unquestionable demonstration as being well-known . . . the notice of facts beyond the record which may be taken by the examiner must be "capable of such instant and unquestionable demonstration as to defy dispute."

Applicants submit that the Official Notice provided in the Office Action does not include facts that are capable of instant and unquestionable demonstration as to defy dispute. Applicants submit that the assertion that the Cartesian coordinate system is an arbitrary labeling of axes is well known in the art is not a fact that is capable of instant and unquestionable demonstration as to defy dispute. Rather, Applicants submit that the Cartesian coordinate system is a specific system for labeling axes, including an X-axis, a Y-axis, and a Z-axis wherein each axis is perpendicular to the other two axes.

The Cartesian coordinate system is not a polar coordinate system, as recited in the presently pending claims. The polar coordinate system is a curvilinear coordinate system, as opposed to the rectangular Cartesian coordinate system. *See*, *The International Dictionary of Applied Mathematics*, eds. W. F. Freiberger et al., D. Van Nostrand Co., Inc., p. 178 (1960), submitted herewith in Appendix A. In the polar coordinate system, a center axis, or *h*-axis, is perpendicular to an r, θ plane. As recited in the presently pending claims, a Z-direction is specified as being substantially parallel to the center axis of an elliptical grid of polar coordinates. One of ordinary skill in the art would understand that choice of a coordinate system is not arbitrary, but rather is dependent on the application.

Further, although Miyazaki describes synthesizing magnetic field gradients in X-, Y-, and Z-direction such that the directions in which the gradients are applied can be changed arbitrarily. Such a description in Miyazaki does not support that assertion that the Cartesian coordinate system is an arbitrary labeling of axes. Rather, Miyazaki merely describes in which direction gradients can be applied in Miyazaki's particular invention. However, none

of the cited reference describes or suggests frequency encoding in a Z-direction that is substantially parallel to a center axis of an elliptical grid of polar coordinates. As such, and in contrast to the Examiner's Official Notice, Applicants submit that whether it is known to use the recited Z-direction is a disputable, questionable fact. Accordingly, Applicants submit that the Official Notice taken in the Office Action is improper.

Further, Applicants respectfully submit that the use of the recited Z-direction would not be obvious to one of ordinary skill in the art at the time the invention was made. Rather, Applicants respectfully submit that a particular direction in a particular coordinate system of a multitude of different directions in different coordinate systems is not obvious to just because it is one possible equation. For the use of the recited equation to be obvious, a rationale or common sense reason to use the particular Z-direction that is substantially parallel to a center axis of an elliptical grid of polar coordinates needs to shown, given all the various, and more possible, directions and coordinates systems that exist. Accordingly, Applicant respectfully it would not be obvious to use the Z-direction recited in the presently pending claims.

Claim 1 recites a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object positioned therein, said method comprising "polar phase encoding to generate a plurality of signals forming datasets representative of the object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said phase encoding comprises phase encoding in which each datum is represented as m(acos(2πd/n)kx + bsin(2πd/n)ky + ickz, a, b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space . . . forming a nested loop by . . . frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i . . . phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding . . . phase encoding radially for n2 number of times . . . phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding . . . and phase encoding rotationally for n3 number of times . . . and outputting an image of the object generated using the datasets."

None of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical

examination using a magnetic resonance imaging (MRI) machine having an object positioned therein as recited in Claim 1. More specifically, none of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Matsui describes a rotating field gradient that produces a spiral or circular sampling of k-space which is then reconstructed to produce an image. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Matsui in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claims 2, 4-7, 9, 10, 12, 16-19, 30, and 31 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2, 4-7, 9, 10, 12, 16-19, 30, and 31 are combined with the recitations of Claim 1, Applicants respectfully submit that Claims 2, 4-7, 9, 10, 12, 16-19, 30, and 31 are likewise patentable over Matsui in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claim 26 recites a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object of interest that is being medically examined positioned therein, said method comprising "sampling datasets on to an elliptical grid in polar coordinates in a k-space to generate signals representative of the object of interest, wherein the dataset are frequency encoded in a Z-direction of the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, said sampling comprises phase encoding in which each datum is represented as m(acos(2πd/n)kx + bsin(2πd/n)ky + ickz, a,

b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space . . . forming a nested loop by . . . frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i . . . phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding . . . phase encoding radially for n2 number of times . . . phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding . . . and phase encoding rotationally for n3 number of times . . . and outputting an image of the object of interest generated using the datasets."

None of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object of interest that is being medically examined positioned therein as recited in Claim 26. More specifically, none of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Matsui describes a rotating field gradient that produces a spiral or circular sampling of k-space which is then reconstructed to produce an image. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 26 is patentable over Matsui in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claim 28 recites a magnetic resonance imaging (MRI) system comprising "a main magnet configured to generate a uniform magnetic field . . . a radio frequency pulse generator configured to excite the magnetic field . . . a gradient field generator configured to generate gradients extending in different directions in the magnetic field . . . a receiver configured to receive magnetic resonance (MR) signals representative of an object . . . and a controller configured to polar phase encode to generate the MR signals forming datasets representative of the object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, said controller further configured to . . . phase encoding by representing each datum as $m(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky + ickz$, a, b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space . . . and form a nested loop by . . . frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i . . . phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding . . . phase encoding radially for n2 number of times . . . phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding . . . and phase encoding rotationally for n3 number of times."

None of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a magnetic resonance imaging (MRI) system as recited in Claim 28. More specifically, none of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a system that includes and controller configured to form a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Matsui describes a rotating field gradient that produces a spiral or circular sampling of k-space which is then reconstructed to produce an image. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum

intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 28 is patentable over Matsui in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claim 29 recites a magnetic resonance (MR) controller electrically coupled to a magnetic resonance imaging (MRI) machine having an object positioned therein, said controller configured to "polar phase encode to generate a plurality of magnetic resonance (MR) signals forming datasets representative of the object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said polar phase encoding comprises phase encoding in which each datum is represented as m(acos(2πd/n)kx + bsin(2πd/n)ky) + jr(acos(2πd/n)kx + bsin(2πd/n)ky) + ickz, a, b, c, d, and r are real numbers, m, j, n, and i are an integers, and kx, ky, and kz being unit vectors in the k-space . . . form a nested loop by . . . frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying i . . . phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every m1 number of times of frequency encoding . . . phase encoding radially for m2 number of times . . . phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding . . . phase encoding translationally for m3 number of times . . . phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding . . . and phase encoding rotationally for m4 number of times . . . and output an image of the object generated from the datasets."

None of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests magnetic resonance (MR) controller electrically coupled to a magnetic resonance imaging (MRI) machine having an object positioned therein as recited in Claim 29. More specifically, none of Matsui, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a controlled configured to form a nested loop by frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying

i, phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every m1 number of times of frequency encoding, phase encoding radially for m2 number of times, phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding, phase encoding translationally for m3 number of times, phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding, and phase encoding rotationally for m4 number of times.

Rather, Matsui describes a rotating field gradient that produces a spiral or circular sampling of k-space which is then reconstructed to produce an image. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 29 is patentable over Matsui in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

For at least the reasons set forth above, Applicants respectfully request that the Section 103 objection of Claims 1, 2, 4-7, 9, 10, 12, 16-19, 26, and 28-31 be withdrawn.

The rejection of Claims 1, 2, 4-7, and 26 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 6,486,670 to Heid (hereinafter referred to as "Heid") in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice is respectfully traversed.

King, Miyazaki, and Goto are described above. The Examiner's Official Notice is traversed and described above.

Heid describes a method for imaging with NMR. The method includes reading out MR signals under the influence of a magnetic gradient field with the direction of a gradient being modified during the reception so that a k-space trajectory proceeds on a curve. The MR signals are then sampled with the sampling rate varied such that an occupation density of k-space with samples is essentially uniform. More specifically, the received magnetic

resonance signals are sampled and digitized according to a time gradient curve. The curved k-space trajectory produces a spiral sampling of k-space. Interpolation samples are arranged on a rectangular grid in k-space and are generated by interpolating (14) the spiral samples (4).

Claim 1 is recited above.

None of Heid, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object positioned therein as recited in Claim 1. More specifically, none of Hedi, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Heid describes a curved k-space trajectory that produces a spiral sampling of k-space, wherein interpolation samples are arranged on a rectangular grid in k-space and are generated by interpolating the spiral samples. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Heid in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claims 2 and 4-7 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2 and 4-7 are combined with the recitations of Claim 1, Applicants respectfully submit that Claims 2 and 4-7 are likewise patentable over Heid in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claim 26 is recited above.

None of Heid, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object of interest that is being medically examined positioned therein as recited in Claim 26. More specifically, none of Hedi, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Heid describes a curved k-space trajectory that produces a spiral sampling of k-space, wherein interpolation samples are arranged on a rectangular grid in k-space and are generated by interpolating the spiral samples. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 26 is patentable over Heid in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

For at least the above reasons Applicants respectfully request that the Section 103 rejection of Claims 1, 2, 4-7, and 26 be withdrawn.

The rejection of Claims 1, 2, 4-7, 9, 10, 14, 19, 20, and 25 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 6,794,869 to Brittain (hereinafter referred to as "Brittain") in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice is respectfully traversed.

King, Miyazaki, and Goto are described above. The Examiner's Official Notice is traversed and described above.

Brittain describes a system and method for acquiring (116) data to reconstruct MR images across a large FOV with a reduced acquisition time and without discontinuities of the reconstructed images. The magnetic field gradients that are used to excite spins traverse k-space in a uniform trajectory in a k-space dimension that is parallel to a motion (146) of an examination table along a Z-axis. More specifically, MR data is acquired (116) by repeatedly applying an excitation that excites spins and by applying magnetic field gradient waveforms to encode a volume of interest (144). The gradients that are perpendicular to the table motion (146) are divided into k_x-k_y subsets. The data is then Fourier transformed in the direction of table motion (146) along the Z-axis, and a final reconstructed image (130) is formed by gridding and Fourier transforming, in a traverse dimension, a fully sampled data array (120). During reconstruction, the phase encodes could be positioned in the k-space plane in the shape of a spiral, in concentric rings, in rays from the center, or in a Cartesian grid.

Claim 1 is recited above.

None of Brittain, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object positioned therein as recited in Claim 1. More specifically, none of Brittain, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Brittain describes a system and method for acquiring data to reconstruct MR images, wherein, during reconstruction, phase encodes can be positioned in a k-space plane in the shape of a spiral, in concentric rings, in rays from the center, or in a Cartesian grid. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum

intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Brittain in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claims 2, 4-7, 9, 10, 14, 19, and 20 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2, 4-7, 9, 10, 14, 19, and 20 are combined with the recitations of Claim 1, Applicants respectfully submit that Claims 2, 4-7, 9, 10, 14, 19, and 20 are likewise patentable over Brittain in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claim 25 recites a magnetic resonance (MR) method for medical examinations using a magnetic resonance imaging (MRI) machine, said method comprising "injecting a patient with a contrast agent that flows into a vasculature of the patient . . . acquiring MR signals produced by spins in the vasculature from an MR imaging system . . . polar phase encoding to generate the MR signals forming datasets representative of the patient by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said polar phase encoding comprises phase encoding in which each datum is represented as $m(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + jr(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + ickz$, a, b, c, d, and r are real numbers, m, j, n, and i are an integers, and kx, ky, and kz being unit vectors in the k-space . . . forming a nested loop by . . . frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying i . . . phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every m1 number of times of frequency encoding . . . phase encoding radially for m2 number of times . . . phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding . . . phase encoding translationally for m3 number of times . . . phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding . . . and phase encoding rotationally for m4 number of times . . . and outputting an image of the patent generated using the datasets."

None of Brittain, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a magnetic resonance method for medical examinations as recited in Claim 25. More specifically, none of Brittain, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying i, phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every m1 number of times of frequency encoding, phase encoding radially for m2 number of times, phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding, phase encoding translationally for m3 number of times, phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding, and phase encoding rotationally for m4 number of times.

Rather, Brittain describes a system and method for acquiring data to reconstruct MR images, wherein, during reconstruction, phase encodes can be positioned in a k-space plane in the shape of a spiral, in concentric rings, in rays from the center, or in a Cartesian grid. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 25 is patentable over Brittain in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

For at least the above reasons, Applicants respectfully request that the Section 103 rejection of Claims 1, 2, 4-7, 9, 10, 14, 19, 20, and 25 be withdrawn.

The rejection of Claims 1, 2, 4-9, 11, 13, and 15 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pub. No. 2002/0175683 to Mertelmeier et al. (hereinafter referred to as "Mertelmeier") in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice is respectfully traversed.

King, Miyazaki, and Goto are described above. The Examiner's Official Notice is traversed and described above.

Mertelmeier describes that the Fourier space, spatial frequency domain or k-space inverse to the spatial or image domain, which the test subject is located, is scanned with a raster of polar coordinates. The graphic presentation of the magnetization, however, is in Cartesian coordinates. The magnetic resonance image then can be generated by re-interpolating the received magnetic resonance signals onto a Cartesian grid and by performing a two-dimensional Fourier transformation. Mertelmeier also describes a method for fast acquisition of a magnetic resonance image. The method includes using a slice selection gradient in the Z-direction of a rectangular XYZ-coordinate system, and using two gradient fields oriented perpendicularly to the Z-direction and to one another, as a field Gx in the X-direction and a field Gy in Y-direction. However, a phase coding gradient is not used, and, instead, only one frequency coding gradient is used, and possibly a slice selection gradient, if the nuclear spins in only one slice are to be excited. The imaging zone (FOV) is subdivided (100) into sub-regions (fov_i), wherein an antenna (14A-14D) of an antenna array (14) is allocated to each sub-region (fov_i). Each antenna (14A-14D) has a known position relative to the projection center, and the antennas (14A-14D) simultaneously receive the magnetic resonance signals. The antennas (14A-14D) respectively form reception signals from the received magnetic resonance signals according to their sensitivity. Partial images are reconstructed and combined.

Claim 1 is recited above.

None of Mertelmeier, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method for a medical examination using a magnetic resonance imaging (MRI) machine having an object positioned therein as recited in Claim 1. More specifically, none of Mertelmeier, King, Miyazaki, Goto, and the assertion of Official Notice, considered alone or in combination, describes or suggests a method that includes forming a nested loop by frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i, phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding, phase encoding radially for n2 number of times, phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding, and phase encoding rotationally for n3 number of times.

Rather, Mertelmeier describes using a slice selection gradient in the Z-direction of a rectangular XYZ-coordinate system, and using two gradient fields oriented perpendicularly to the Z-direction and to one another, as a field Gx in the X-direction and a field Gy in Y-direction. However, a phase coding gradient is not used, and, instead, only one frequency coding gradient is used, and possibly a slice selection gradient, if the nuclear spins in only one slice are to be excited. King describes a method of magnetic resonance imaging using sampling points on an anisotropic spiral trajectory, Miyazaki describes data reconstruction through pixel addition or maximum intensity projection (MIP), and Goto describes a method of magnetic resonance imaging incorporating pulse sequences which are repeated. The Official Notice merely describes that the Cartesian coordinate system is a labeling of axes.

Accordingly, Applicants respectfully submit that Claim 1 is patentable over Mertelmeier in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

Claims 2, 4-9, 11, 13 and 15 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2, 4-9, 11, 13 and 15 are combined with the recitations of Claim 1, Applicants respectfully submit that Claims 2, 4-9, 11, 13 and 15 are likewise patentable over Mertelmeier in view of King, further in view of Miyazaki, and further in view of Goto and the Examiner's Official Notice.

For at least the above reasons, Applicants respectfully request that the Section 103 rejection of Claims 1, 2, 4-9, 11, 13, and 15 be withdrawn.

In view of the foregoing amendment and remarks, all the claims now active in this application are believed to be in condition for allowance. Reconsideration and favorable action are respectfully solicited.

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Appendix A

THE INTERNATIONAL DICTIONARY OF APPLIED MATHEMATICS

[redacted]

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tion of ξ obtained by integrating over the course of α may then be described as compound.

CONVOLUTION INTEGRAL. See first paragraph under **convolution.**

CONVOLUTION THEOREM. See **Laplace transform theorems.**

CONWELL-WEISSKOPF FORMULA. The **mobility** μ of electrons in a **semiconductor** in the presence of donor or acceptor impurities is given by

$$\mu = [2^{7/2}\epsilon^2(kT)^{3/2} \log (1 + x^2)]/N e^{\pi^{3/2} e^3 m^{1/2}}$$

where

$$x = 6\epsilon dkT/e^2$$

and ϵ is the dielectric constant of the medium, N is the concentration of ionized donors (or acceptors), $2d$ is the average distance between ionized donors, e and m the electronic charge and mass, etc.

COOLANT. The fluid used to carry heat away from a system or device, such as an internal combustion engine, etc.

COOLING. The process of reducing the temperature of a body or of extracting heat by circulating a fluid **(coolant).**

COOLING BY ADIABATIC DEMAGNETIZATION. See **adiabatic demagnetization.**

COOPERATIVE PHENOMENA. Such processes as order-disorder transformations in binary alloys, ferromagnetism, and melting, where certain subsystems will combine to form units which hold together in spite of the disrupting influence of thermal agitation.

It is to a large extent possible to treat all these phenomena at the same time. The simplest model for such systems, and the one most investigated, is the **Ising model.**

If one considers a simple cubic AB **substitutional alloy,** depending on whether the energy of an AB pair is less or larger than the average of an AA and a BB pair, there will be a tendency for order, that is, for the formation of a superstructure of two sublattices, one a pure A and one a pure B lattice, where each A atom is surrounded by B atoms and vice versa, or a tendency for phase separation. At the absolute zero the order will be complete, but when the temperature is increased, there will be a chance that an A atom will move to the place of a B atom (β-site) and thus be replaced by a B atom on an α-site. The presence of an A atom on a β-site will induce a tendency for the neighboring α-sites to be occupied by B atoms, and a disordering tendency will set in which will lead to an avalanche effect, and at and above the **Curie temperature** there will no longer be a tendency of A atoms to be on α-sites, or B atoms to be on β-sites, but there will still be a tendency for A atoms to be surrounded by B atoms and vice versa. The short range order parameter measures this latter tendency while the long range order parameter measures the tendency of A atoms to be on α-sites.

In any statistical treatment of cooperative phenomena one derives an (approximate) expression of the free energy in terms of the two order parameters, and by evaluating its extremum, the equilibrium values of the order parameters are found. The statistical approximations which are used most are the Bragg-Williams, and the **quasi-chemical approximation.**

COORDINATE. One of a set of numbers which determine the position in space of a geometric entity, usually a point but sometimes a line, surface, etc., in such a way that a continuous change in the coordinates corresponds to a continuous change of position, and conversely. The commonest system of coordinates is the Cartesian (or rectangular Cartesian) system in the plane or in 3-dimensional space. In a plane, the **homogeneous** coordinates of a point, whose Cartesian coordinates are x and y, are any three (not all zero) numbers (x_1, x_2, x_3) for which $x_1/x_3 = x$ and $x_2/x_3 = y$. The points for which $x_3 = 0$ form the **line** at **infinity.** Homogeneous coordinates are defined analogously for spaces of 3 or more dimensions. If $u = u(x,y)$ and $v = v(x,y)$, then p,q are the **curvilinear coordinates** (the u,v coordinates) of a point P if P is the intersection of the curve $u(x,y) = p$ with the curve $v(x,y) = q$. Commonly used coordinates of this sort are **polar, cylindrical, spherical, elliptic and parabolic coordinates.**

COORDINATE BOND. Some molecules, such as H_2O, NH_3, HF, HCl $\cdots$ have in their outer shell one or more free electron doublets which they can eventually share with an atom